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Monitoring for Non-Occupational Exposure to Pesticides in Indoor and Personal Respiratory Air

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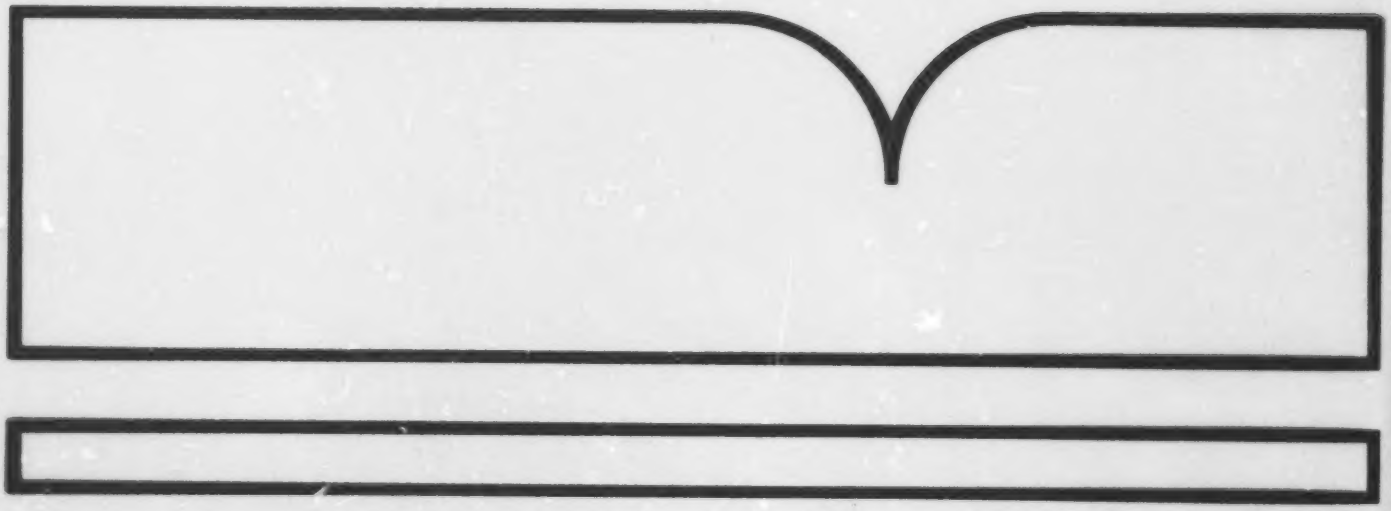

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MONITORING FOR NON-OCCUPATIONAL EXPOSURE TO PESTICIDES IN INDOOR AND PERSONAL RESPIRATORY AIR

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16. ABSTRACT

Methodology based on collection of pesticides on polyurethane foam and analysis by gas chromatography-mass spectrometry was evaluated for 30 pesticides commonly used in and around the home. As part of a 9-home pilot study in an urban-suburban area of the southeastern U.S., air samples were collected over 24-hr periods inside and outside of private residences. In addition, one resident from each home wore or kept nearby portable samplers to determine personal exposure while at home or away. Over 20 of the target pesticides were detected in indoor air at levels above the 0.01 $\mu g/m^3$ detection limit. Air concentrations were significantly higher indoors than outdoors, and more pesticides were detected indoors. The most prevalent pesticides (and their average concentrations) were chlorpyrifos (2.3 $\mu g/m^3$), diazinon (1.4 $\mu g/m^3$), chlordane (0.5 $\mu g/m^3$), propoxur (0.04 $\mu g/m^3$) and heptachlor (0.09 $\mu g/m^3$). Personal exposure monitoring revealed air concentrations which were generally similar to the simultaneously-determined indoor air levels, suggesting that most of the respiratory exposure occurred within the house. Collocated samplers operated at flow rates of 1.2 to 225 L/min yielded similar results.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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Introduction

A broad spectrum of pesticides are commonly used in and around the home to control pests ranging from termites to Japanese beetles and fungi to crabgrass. Depending upon the manner of use or application, human exposure to pesticides may occur through respiration, ingestion, dermal absorption, or any combination thereof. Little human exposure data is available which can be used to estimate potential health effects due to household pesticides or the relative importance of the different routes of exposure. For example, occupational exposures to airborne pesticides are well documented,[1,2] but few studies have been conducted to determine typical air route exposures associated with the use of home and garden pesticides.[3,4] Concern over the lack of information regarding non-occupational exposures to pesticides prompted the passage of a Congressional appropriations bill in 1985 which provided funds for a total exposure assessment study by the U. S. Environmental Protection Agency.

The primary objective of the study is to obtain an estimation of the cumulative frequency distributions of non-occupational exposures to the most commonly used home and garden pesticides through the air, dermal, drinking water, and dietary routes. Secondary objectives are to (1) obtain an estimate of the relative importance of each route to the total exposure, (2) identify probable sources of the pesticides, and (3) compare indoor with outdoor air levels. The design of this study, called the Non-Occupational Pesticides Exposure Study (NOPES), is based on that of the Total Exposure Assessment Methodology (TEAM) studies previously conducted by EPA.[5,6]

A pilot study encompassing nine households was conducted during August 1985 in an urban-suburban area of the southeastern United States selected on the basis of high pesticide usage. The purpose of the pilot study was to select, validate and field-test sampling methodologies and survey questionnaires to be used in the subsequent, 200-household study. The residents of these households were generally retired or semi-retired persons, who spent the majority of their time indoors (15 to 22 hr/day; avg. 18 hr), and consequently did not represent a normal population.

Fixed-position indoor and outdoor and personal exposure (portable sampler) air monitoring was performed at each of nine single-family dwellings, which were classified on the basis of questionnaire results as low, medium, or high pesticide usage households (three in each category). In addition, tap water samples from each house were analyzed. A limited number of dermal exposure measurements were made by analysis of pre-extracted white cotton gloves worn by selected individuals during application of pesticides. Samples of each of these media were analyzed for each of 26 pesticides listed in Table I. These compounds were selected on the basis of present-day or historical usage and potential human toxicity concerns. Three other high-use pesticides, glyphosate, acephate and p-dichlorobenzene were originally targeted for the study, but were dropped because of special sampling or analytical requirements. The two pesticide metabolites or oxidation products (oxychlordane and heptachlor epoxide), a component of technical chlordane (trans-nonachlor) and two polychlorinated biphenyls (Aroclors 1242 and 1260) were added because they could be easily fitted

into the monitoring program and were worthy of interest. In this paper, we will discuss only the air monitoring portion of the pilot study.

Sampling Methodology

Two sampling systems were used in this study. For most of the fixed-position indoor and outdoor ambient air sampling and all of the personal air monitoring, a low-volume (LV) sampler[4] was employed. The components of the LV sampler consisted of a constant-flow pump (DuPont Model P-4000A) and a glass cartridge containing a 22-mm diameter x 7.6-cm long cylinder of polyurethane foam (PUF). In advance of the pilot study, 24-hr. sampling efficiencies at 3.8 L/min were determined for each of the 30 target chemicals at 0.01, 0.1 and 1.0 $\mu g/m^3$ of air using the procedures of Lewis and MacLeod.[4] The overall sampling and analytical efficiencies were 70-100% for most of the compounds. Exceptions were bendiocarb (avg. 45%), dicofol (avg. 57%), 2,4-D methyl ester (avg. 58%), and pentachlorophenol (avg. 60%). Sampling efficiencies and associated precision data for five of the most commonly encountered pesticides are given in Table II.

At selected households, a high-volume (HV) air sampler[7] was operated for 24-hr periods at 225 L/min in order to collect samples large enough for exploratory investigations. This HV sampler was modified for indoor use by placing the sampling module on a tripod and locating the pump outside of the dwelling.[8] The HV sampler was not evaluated for all of the chemicals in Table I. However, it had been previously evaluated for several of these compounds and others of similar chemical structure.[9]

Three different sets of ambient air samples were collected over 24-hr sampling periods in each usage category. These are summarized in Table III. All sets included a primary group of samples, comprised of an inside LV sample (3.8 L/min), an outside LV sample (3.8 L/min), and a personal exposure (PE) sample (3.8 L/min). One house in each category was selected for a distributed air volume (DAV) set,[10] which consisted of two additional inside LV samples (1.2 and 2.0 L/min), two additional outside LV samples (1.2 and 2.0 L/min), and inside and outside HV samples (225 L/min). Duplicate (collocated) inside and outside HV air samples were collected at the medium usage DAV house. The second house in each usage category was picked for duplicate sampling. Inside and outside LV (3.8 L/min) duplicate samples were collected simultaneously with the primary group at these households. The third house in each category was designated for replicate sampling, in which a second group of samples was collected during a subsequent 24-hr period at least 24 hours past the conclusion of the primary group of samples. Indoor air samples were collected in an area of high daily family activity, such as a kitchen or family room. Outdoor air samples were collected in or adjacent to an area of high traffic outdoor activity (e.g., on a side porch or patio).

Indoors, all LV fixed-station samples were collected with intakes positioned horizontally at heights of 1.0 to 1.6 m above the floor. Outdoors, LV samples were attached to various supports with intakes generally about 1.5 m above ground and oriented downward. The HV sampler intake was oriented upward and located 1.5 m above

the floor inside and 1.2 m above ground outside. Covers protected the HV sampler intakes from dust-fall.

Personal monitors were carried by one resident of each household. During periods of activity, this sampler was carried in a case with a shoulder strap so that the intake was located at waist level and pointed behind the wearer. During periods of inactivity (i.e., when the person was not moving from room-to-room), the PE sampler may have been located on a nearby table or counter top. The LV pumps were battery-operated only when carried on the person.

When duplicate or DAV samples were collected simultaneously with the primary samples, LV samplers were placed with a separation of 0.3 m. The inlets to the cartridges were arranged such that sufficient distances were maintained between sampler exhausts and inlets. HV air samplers in the DAV households were placed in the same area as the LV samplers with a minimum separation of 2 m. Duplicate HV samplers were separated by 1 m for the outdoor set and 2 m for the indoor set.

The Du Pont sampling pumps were calibrated with a Du Pont calibrator pack (catalog no. 66-242-f-1). The HV samplers were calibrated by means of a calibrated venturi tube which was attached to the inlet. With two exceptions, an operational check and a flow check were performed on each sampler at one time during the 24 hr sampling period. In all cases, flows were checked at the end of each sampling period. In addition, flow audits were conducted in the field by an independent team using two laminar flow elements calibrated by the National Bureau of Standards (NBS). All samplers in use during the audit period were found to within ±5% of the set flow rates.

Local barometric and ambient temperature values were obtained at 4-hr intervals throughout the study period from the National Weather Service. Barometric pressure for a 24-hr sampling period was calculated by averaging the six values observed during that period. Likewise, ambient air temperatures for outside air samples were calculated from the appropriate observations. Outdoor temperatures ranged from lows of 23-24°C to highs of 29-32°C during the study. Air temperatures for indoor samples and exposure samples were dependent on air conditioning use and the activity of the monitored individual.

The nine domiciles monitored ranged in type from a mobile home to a two-bedroom apartment to houses of up to 2000 sq. ft. built on concrete slabs or over crawl spaces. A total of 74 air samples were collected and analyzed along with six field blanks. Some of these samples and/or aliquots of sample extracts were shared with a referee laboratory. All samples were kept at temperatures below 4°C from immediately after collection until they were analyzed (including during shipment). All samples were extracted within 14 days and analyzed within 21 days of collection. The percent relative standard deviation between duplicate samples collected in the field were in the 20 to 30% range.

Analytical Methodology

The PUF plugs were precleaned by Soxhlet extraction with acetone as previously described,[9] vacuum dried, and loaded into the appropriate glass sampling cartridges under clean laboratory conditions. The cartridges were wrapped in hexane-rinsed alum-

inum foil and stored in carefully cleaned glass jars padded with clean PUF for transport to and from the sampling sites in freezer chests cooled with dry ice. Exposed filters from the HV samplers were completely wrapped in prerinsed foil and placed in the jars with the PUF cartridge. Disposable latex surgical gloves and pre-rinsed tongs were used for handling the sampling cartridges when PUF plugs were loaded and unloaded in the laboratory and for attaching them to the sampling systems in the field.

Exposed PUF plugs and filters were Soxhlet extracted together with 5% diethyl ether in hexane following the procedure of Lewis et al.[4,9] The extracts were reduced to 10 or 0.2 mL in Kuderna-Danish concentrators for analysis by gas chromatography with electron capture detection (GC/ECD) or gas chromatography-mass spectrometry (GC/MS), respectively. A 0.25-mm x 30-m DB-5 capillary column (0.25-μm film thickness) with helium carrier gas (1 mL/min) was used for both GC/ECD and GC/MS analyses. Temperature programming from 90° (4 min) to 270°C (4°/min) for GC/ECD and 40° (2 min) to 295°C (10°/min) for GC/MS separated 29 of the 30 target compounds. Electron ionization MS with multiple ion detection (MID) was used to confirm all compounds and to quantitate chlorpyrifos, which could not be separated from dacthal. An external standard method was used for the quantitation of GC/ECD results. However, quantitation with GC/MS/MID was based on the use of two internal standards, D10-phenanthrene and D12-chrysene. This analytical methodology was validated for all of the compounds listed in Table I prior to collection of field samples. For this purpose authentic reference standards obtained from the U.S. EPA Pesticides and Industrial Chemical Repository, Research Triangle Park, North Carolina were used. All chemicals could be quantitated at levels of 10 ng/m^3 in LV samples and 1 ng/m^3 or below in HV samples.

Results and Discussion

There were no consistent differences in measured air concentrations from simultaneous LV samples collected at 3.8, 2.0 and 1.2 L/min, indicating that none of the pesticides collected broke through the PUF. Concentration values were often very similar at the three sampling rates (±10%). Differences of an order of magnitude occurred occasionally, but in no predictable manner. As expected, somewhat fewer compounds were detected at 1.2 L/min. A few more compounds were detected indoors by the HV sampler, usually at low concentrations. Many more compounds were measurable in the air out-of-doors (again, usually at lower concentrations) when the HV sampler was used. The LV sampling rate of 3.8 L/min appeared to be well-suited for the study.

Of the 30 pesticides and related chemicals listed in Table I, a total of 22 were detected in the indoor air samples collected. Concentrations ranged from 1.7 ng/m^3 to 15.0 μg/m^3. Not detected in any indoor air sample were permethrin, resmethrin, carbaryl, 2,4-D esters, atrazine, dacthal, and PCBs. Of these, only trans-permethrin was found on one occasion in the outdoor air. A summary of positive findings is given in Table IV. Outdoor air levels were generally much lower than indoor air levels, ranging from 1.0 ng/m^3 to 410 ng/m^3. Personal exposure measurements ranged from <10 ng/m^3 to 7.3 μg/m^3.

The pesticides present and their concentrations in the ambient outdoor air differed greatly from one household to another. There was no evidence of a common back-

ground profile for outdoor air throughout the overall study area or within given neighborhoods. Instead, the data were consistent with the presence of numerous localized outdoor sources, probably in the immediate vicinity of each household. Therefore, it may not be valid to use one outdoor air sample to represent a cluster of homes. Ideally, comparisons of indoor with outdoor air quality should only be made for a given household and immediately adjacent property.

When the LV samplers were used, only two or three pesticides could be measured in the outdoor air. However, an average of 14 to 15 were quantifiable with the HV sampler.

The average number of target pesticides found in the air inside of the three households considered to have high pesticide usage was 11, compared to an average of seven in the medium-usage and five in the low-usage dwellings. As many as 20 pesticides were identified in the air of one high-usage household.

The most commonly encountered pesticides are shown in Table V. The concentrations of these five pesticides were generally about one order of magnitude higher than those of any other pesticide found in some samples. Indoor air levels were almost always one to two orders of magnitude higher than outdoor levels. In the majority of cases, the same pesticides that were found to be the most prevalent in indoor air were also identified in an independent survey to be ingredients of pesticidal products found at the household or used by the occupants or recently applied by professional pest control operators. In fact, 70 to 100% of the pesticides identified in indoor air could be ascribed to indoor sources. The composition of the air inside each dwelling appeared to have its own characteristic profile in terms of identity and levels of the pesticides present. There was remarkably little day-to-day variation in the composition of either the indoor air or personal exposure samples.

With few exceptions, the personal exposure samples exhibited the same profiles as those of the resident households. An example for one high-use household is presented in Table VI. For specific pesticides, personal exposure measurements were generally within ± 50% of the corresponding indoor air measurements. In every PE air sample obtained, at least two-thirds of the pesticides found were also present in the corresponding indoor air samples. Overall, 81% of the total respiratory exposures of the participants could be attributed to breathing the air within their homes.

Conclusions

The results of the pilot study clearly show that the numbers and concentrations of pesticides in domiciliary indoor air were significantly higher than those in the immediately surrounding outdoor air. They also demonstrate the reliability of the field survey and questionnaire process in stratifying the households by degree of pesticide usage.

The study showed that the LV sampling system operated at 3.8 L/min was effective for monitoring all of the pesticides of interest and related compounds. In the pilot study area, indoor and personal exposure air concentrations were generally large enough

to be reliably measured with a 12-hr sample, rather than the 24-hr sample taken. The very strong correlation between residential fixed-station indoor air monitoring and personal air exposure in this study probably resulted because the participants spent unusually large proportions of the time inside their homes. Separate 12-hr daytime and nighttime samples should provide a better indication of the proportion of the exposure between home and workplace for the average family member. However, the additional costs involved, especially for analyses, would likely reduce the size of a given study (in this case, the full NOPES project), and the additional information would not be essential to determination of chronic air route exposures.

There was an apparent lack of correlation of the personal air monitoring data with the potential exposures associated with application of pesticidal products. This may be due to the fact that there was very little activity of this type during the study period. Only one person reported that he applied pesticides while wearing the monitor. In this case, elevated levels of the pesticides, dichlorvos and propoxur, were found on the gloves he wore, but only dichlorvos was found to be significantly elevated in the PE air sample (290 ng/m^3 vs. non-detectable in the indoor air sample). The low volatility of propoxur may account for its absence in the PE air sample. Two other participants spent about 30 min. each working in their gardens with no apparent indications resulting from the air monitors they carried. In two other cases, PE air levels of chlorpyrifos were significantly higher than corresponding indoor air levels for persons with pets known to be treated with this insecticide for flea and tick control. It should also be emphasized that, since the PE samplers were operated for 24 hr, short exposure results would be greatly diluted in the samples.

The indoor and PE air concentrations found in this study probably represent upper levels for the conterminous United States. The project was carried out during the summertime in a state which has the highest pesticides usage in the Southeast. Of the nine study homes, seven were known to have been treated for termites, six within the past one to five years. Six received professional indoor pest treatments on a regular basis (as often as monthly) and all had inventories of pesticidal products which were used in and around the households by the occupants.

The absence in air of the popular pesticides carbaryl and captan, both of which were used at several of the study households, may be explained by their low volatilities and the relative difficulty in analyzing samples for these compounds. The non-detectable levels of polychlorinated biphenyls (< 20 ng/m^3) appears to be in contrast with previous findings,[11] and may reflect current trends.

The overall conduct of the pilot study was relatively trouble-free. The portable (LV) samplers were unobtrusive and provided an adequate sample size for GC/MS analysis. The Du Pont P4000 pumps were very reliable in operation and afforded precise flow control. The PE air samplers were convenient to use as prescribed in the pilot study. The better assessment of chronic exposures to pesticides is the major goal of the NOPES project. Should information relative to acute exposures be sought in future studies, consideration should be given to adding a second PE sampler for pesticide application and gardening activities. In this study, gloves for dermal exposure monitoring were worn only during these periods, since it was felt that dermal exposures at other times

would be insignificant. Similar use of air monitors would provide a better estimate of respiratory exposure during these times since the samples would not be diluted by the relatively clean air sampled over longer periods. This approach would also permit some assessment of the relative importance of respiratory versus dermal exposures when an individual is in intimate contact with household pesticides.

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Table I. Compounds Monitored

Compound	Type of Pesticide	Household Uses Leading to Potential Human Exposure*
Chlorpyrifos (Dursban®)	Insecticide	Control of mosquitos, cockroaches and other household insects; turf and ornamental insects; fire ants, termites, and lice
Pentachlorophenol	Fungicide, Insecticide	Exterior wood preservative
Chlordane	Insecticide	Subterranean termite control
Ortho-Phenylphenol	Disinfectant, Fungicide	Household disinfectant; post-harvest application in wax applied to fruits and vegatables
Propoxur (Baygon®)	Insecticide	Control of cockroaches, flies, mosquitos; lawn and turf insects
Resmethrin	Insecticide	Control of flying and crawling insects; fabric protection; pet sprays and shampoos; application on horses and in horse stables
Dicofol	Insecticide	Control of mites on fruit, vegetable, and ornamental crops
Captan	Fungicide	Seed protectant; fungal control on fruits, vegetables, and berries
Carbaryl (Sevin®)	Insecticide	Control of insects on lawns, ornamentals, shade trees, vegetables, and pets
Lindane (γ-BHC)	Insecticide	Seed treatment; insect control in soil, on vegetables, ornamentals, and fruit and nut trees

Table I. Compounds Monitored
(continued)

Compound	Type of Pesticide	Household Uses Leading to Potential Human Exposure*
Dichlorvos (DDVP)	Insecticide	Household and public health insect control; flea collars and no-pest strips
2,4-D esters	Herbicide	Postemergent weed control
Malathion	Insecticide	Insect control on fruits, vegetables, ornamentals and inside homes
Permethrin (*cis* and *trans*)	Insecticide	Control of flies, mosquitos, ants, cockroaches, garden insects
Heptachlor	Insecticide	Subterranean termite control
Aldrin	Insecticide	Control of soil insects, especially termites
Dieldrin	Insecticide	Control of soil insects, public health insects, termites
Ronnel	Insecticide	Fly and cockroach control
Diazinon	Insecticide, Nematicide	Control of soil and household insects, grubs and nematodes in turf; seed treatment and fly control
Methoxychlor	Insecticide	Control of insects in garden, fruit, and shade trees
Atrazine	Herbicide	Non-selective weed control
α-Hexachlorocyclohexane (α-BHC)	Insecticide	Manufacture and use discontinued in U.S.; ubiquitous in air, residue from lindane

Table I. Compounds Monitored
(continued)

Compound	Type of Pesticide	Household Uses Leading to Potential Human Exposure*
Bendiocarb (Ficam®)	Insecticide	Household, ornamental, and turf insect control
Folpet	Fungicide	Fungus control on flowers, ornamentals, seeds, plant beds; paints and plastics
Chlorothalonil (Bravo®)	Fungicide	Broad spectrum fungicide; wood preservative; paint additive
Dacthal	Herbicide	Selective pre-emergent weed control on turf, ornamentals, and vegetable crops
Oxychlordane	--	Oxidation product of chlordane
Heptachlor epoxide	--	Oxidation product of heptachlor
trans-Nonachlor	--	Component of chlordane
PCBs (Aroclors 1242 and 1260)	--	Used in electrical transformers until 1976

* Source: Farm Chemicals Handbook, 1985, Meister Publishing Co., Willoughby, Ohio.

Table II. Sampling Efficiencies for Most Prevalent Pesticides

Pesticide	Sampling Efficiency,*%	RSD, %
Chlorpyrifos	93	29
Diazinon	72	30
Chlordane (technical)	95	29
Propoxur	95	20
Heptachlor	99	13

* Average of 3 determinations at each of three air concentrations.

Table III. Type and Distribution of Air Samples

Sample type	Usage Category (house number)								
	Low			Medium			High		
	1	2	3	1	2	3	1	2	3
Primary samples, LV (3.8 L/min)									
Inside	x	x	x	x	x	x	x	x	x
Outside	x	x	x	x	x	x	x	x	x
Exposure	x	x	x	x	x	x	x	x	x
Duplicate samples, LV (3.8 L/min)									
Inside		x			x			x	
Outside		x			x			x	
Replicate samples, LV (3.8 L/min)									
Inside			x			x			x
Outside			x			x			x
Exposure			x			x			x
Distributed air volume samples									
Inside (1.2 L/min)	x			x			x		
Inside (2.0 L/min)	x			x			x		
Outside (1.2 L/min)	x			x			x		
Outside (2.0 L/min)	x			x			x		
High-volume air samples (225 L/min)									
Inside	x			x			x		
Outside	x			x			x		
Inside, duplicate.				x					
Outside, duplicate				x					

Table IV. Summary of Pesticides Found in Air

Pesticide	Number of Households at Which Detected in Air		
	Indoors	Outdoors	Respiratory
Chlorpyrifos	9	7	8
Diazinon	8	7	6
Chlordane	8	6	6
Propoxur	7	4	6
Heptachlor	7	5	6
trans-Nonachlor	5	3	5
o-Phenylphenol	5	4	5
Dieldrin	5	3	5
Lindane	5	2	3
Heptachlor epoxide	5	2	3
Aldrin	4	4	3
Ronnel	4	1	3
Captan	4	1	3
Bendiocarb	3	1	3
α-BHC	3	2	3
Folpet	3	4	3
Malathion	3	2	1
Chlorothalonil	3	3	1
Oxychlordane	2	3	1
Dichlorvos	2	1	0
Dicofol	1	2	0
Methoxychlor	1	1	0
Pentachlorophenol	1	1	0
trans-Permethrin	0	1	0

Table V. Summary of Monitoring Data for Most Prevalent Pesticides

Pesticide		Air Concentration, ng/m^3		
		Indoor	Outdoor	Personal Exposure
Chlorpyrifos	Range	14-15,000	ND-300	ND-8,800
	Mean	2,400	59	1,900
	Positive	9/9	7/9	8/9
Diazinon	Range	ND-8,800	ND-410	ND-5,100
	Mean	1,400	109	852
	Positive	8/9	7/9	6/9
Chlordane	Range	ND-1,700	ND-210	ND-4,200
	Mean	510	58	684
	Positive	8/9	6/9	6/9
Propoxur	Range	ND-655	ND-3.9	ND-600
	Mean	42	3.4	100
	Positive	7/9	4/9	6/9
Heptachlor	Range	ND-314	ND-48	ND-180
	Mean	88	16	60
	Positive	7/9	5/9	6/9

* ND = Not detected at ca. 1 ng/m^3

Table VI. Comparison of Indoor, Outdoor and Personal Exposure Air Samples in One High-Use Household

Pesticide	Air Concentration, ng/m^3					
	Indoor		Outdoor		Personal	
	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Chlorpyrifos	15,000	6,600	75	160	5,800	8,800
Diazinon	3,200	1,600	ND	47	1,000	2,100
Chlordane	1,700	1,700	64	44	640	650
o-Phenylphenol	390	370	ND*	ND	110	500
Heptachlor	160	200	ND	ND	84	42
trans-Nonachlor	100	170	ND	ND	34	39
Aldrin	55	61	ND	ND	23	26
Captan	37	72	ND	ND	19	28
Ronnel	37	47	ND	ND	21	ND
Dieldrin	35	40	ND	ND	11	15
Oxychlordane	33	39	ND	ND	26	50
Heptachlor Epoxide	31	37	ND	ND	24	47
Propoxur	46	19	ND	ND	ND	21
Lindane	12	ND	ND	ND	ND	ND
α-BHC	ND	ND	ND	ND	12	ND
Folpet	ND	ND	16	18	190	23

* Not detected at ca. 10 ng/m^3